GEOLOGY AND PALEONTOLOGY

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SUMMARY OF CONCLUSIONS

The proposed Hidden Hills Solar Electric Generating System (HHSEGS) site is located in an active geologic area along the border between Southern California and Southern Nevada, approximately 45 miles west of Las Vegas Nevada and 57 miles southeast of Death Valley, California. Because of its geologic setting, the site could be subject to strong levels of earthquake-related ground shaking. The closest known active fault is a segment of the Pahrump Valley Fault Zone which is located approximately 1,500 feet northeast of the proposed project site (**Geological Resources - Figure 1**). Additional active faults in the vicinity of the project site are the Garlock fault (35 miles southwest of the site) and the Southern Death Valley fault zone (38 miles to the southwest) (**Geological Resources - Figure 2**). The potential significant effects of strong ground shaking on the HHSEGS structures must be mitigated through structural designs required by the most recent edition of the California Building Code (CBC 2010). CBC 2010 requires that structures be designed to resist seismic stresses from ground acceleration and, to a lesser extent, liquefaction potential.

In addition to strong seismic shaking, the project may be subject to soil failure caused by hydrocollapse, formation of soil fissures and/or dynamic compaction. A design-level geotechnical investigation required for the project by the CBC 2010, and proposed **FACILITY DESIGN CONDITIONS OF CERTIFICATION GEN-1**, **GEN-5** and **CIVIL-1**, would present standard engineering design requirements for mitigation of strong seismic shaking and potential excessive settlement due to collapsible soils, formation of soil fissures and/or dynamic compaction.

There are no known viable geologic or mineralogical resources at the proposed HHSEGS site. Unique geological features (paleosprings) that exist east of the site are associated with fault scarps belonging to segments of the Pahrump Valley fault zone. There is no evidence of the existence of paleosprings on the site. However, channels and associated deposits formed by flows from these springs may traverse the site. Paleontological resources have been documented within 3 miles of the project, but no significant fossils were found during field explorations at the project site or near ancillary facilities (HHSG 2011a § 5.8). Potential impacts to paleontological resources due to construction activities would be mitigated through worker training and monitoring by qualified paleontologists, as required by proposed **CONDITIONS OF CERTIFICATION PAL-1** through **PAL-7**.

Based on this information, Energy Commission staff concludes that the potential adverse cumulative impacts to project facilities from geologic hazards during its design life, if any, are less than significant. Similarly, staff concludes the potential adverse cumulative impacts to potential geologic, mineralogic, and paleontologic resources from the construction, operation, and closure of the proposed project, if any, are less than significant. It is staff's opinion that the proposed HHSEGS can be designed and constructed in accordance with all applicable laws, ordinances, regulations, and standards (LORS), and in a manner that both protects environmental quality and assures public safety.

INTRODUCTION

In this section, California Energy Commission (Energy Commission) staff discusses the potential impacts of geologic hazards on the proposed HHSEGS facility as well as the HHSEGS's potential impact on geologic, mineralogic, and paleontologic resources. Staff's objective is to identify resources that could be significantly adversely affected, evaluate the potential of the project construction and operation to significantly impact the resources and provide mitigation measures as necessary to ensure that there would be no significant adverse impacts to geological and paleontological resources during the project construction, operation, and closure and to ensure that operation of the plant would not expose occupants to high-probability geologic hazards. A brief geological and paleontological overview is provided. The section concludes with staff's proposed conditions of certification - *i.e*., monitoring and mitigation measures that, if implemented, would reduce any project impacts to geologic hazards and geologic, mineralogic, and paleontologic resources to insignificant levels.

LAWS, ORDINANCES, REGULATIONS AND STANDARDS (LORS)

Applicable laws, ordinances, regulations and standards (LORS) are listed in the application for certification (AFC) (HHSG 2011a § 5.8). The following briefly describes the current LORS for both geologic hazards and resources and mineralogic and paleontologic resources.

Geology and Paleontology Table 1
Laws, Ordinances, Regulations, and Standards (LORS)

Applicable Law	**Description**
Federal	***Portions of the utility corridor are on federal land***
National Environmental Policy Act (NEPA) of 1969	NEPA establishes a public, interdisciplinary framework for Federal decision-making and ensures that federal agencies take environmental factors into account when considering Federal actions.
Antiquities Act of 1906	Provides for protection of objects of antiquity on federal lands.
Omnibus Public Land Management Act of 2009, Title VI—Department of the Interior Authorizations, Subtitle D—Paleontological Resources Preservation	Directs the secretaries of the Interior and Agriculture to manage paleontological resources on BLM and USFS land using scientific principles and expertise, and to inventory paleontological resources on those lands.

Applicable Law	Description
State	
California Building Code (2010)	The California Building Code (CBC 2010) includes a series of standards that are used in project investigation, design, and construction (including seismicity, grading and erosion control). The CBC has adopted provisions in the International Building Code (IBC, 2009).
Alquist-Priolo Earthquake Fault Zoning Act, Public Resources Code (PRC), section 2621–2630	Mitigates against surface fault rupture of known active faults beneath occupied structures. Requires disclosure to potential buyers of existing real estate and a 50-foot setback for new occupied buildings.
The Seismic Hazards Mapping Act, PRC section 2690–2699	Areas are identified that are subject to the effects of strong ground shaking, such as liquefaction, landslides, tsunamis, and seiches.
CEQA, Appendix G Environmental Checklist Form	Asks if project would have impacts on paleontological resources or a unique geological feature.
Local	
County of Inyo General Plan	Compliance with the Public Safety Element of the General Plan. The Plan does not specifically address paleontological resources. However, it places emphasis on the preservation of historic and prehistoric resources and values.
Standards	
Society for Vertebrate Paleontology (SVP), 1995	The “Measures for Assessment and Mitigation of Adverse Impacts to Non-Renewable Paleontological Resources: Standard Procedures” is a set of procedures and standards for assessing and mitigating impacts to vertebrate paleontological resources. The measures were adopted in October 1995 by the SVP, a national organization of professional scientists.
Bureau of Land Management (BLM) Instructional Memorandum 2008-009	Provides up-to-date methodologies for assessing paleontological sensitivity and management guidelines for paleontological resources on lands managed by the Bureau of Land Management.

SETTING

The proposed HHSEGS project will be located on approximately 3,277 acres of privately-owned land leased in Inyo County, California, adjacent to the Nevada border. The site is approximately 8 miles directly south of Pahrump, Nevada (with a driving distance of 28 miles), and approximately 45 miles west of Las Vegas, Nevada. As detailed in the **PROJECT DESCRIPTION** section of this final staff assessment (**FSA)**, HHSEGS will include the construction of the 500 MW power plant (consisting of Solar Plant 1, Solar Plant 2 and a common area), natural gas supply lines, sewer and storm water collection and conveyance features, transmission lines, and water supply infrastructure.

REGIONAL SETTING

HHSEGS lies in the Pahrump Valley, within the Basin and Range physiographic province (Cook 2004) (**Geological Resources - Figure 3**). The province extends south from southeastern Oregon between the Sierra Nevada and the Wasatch Range of Utah, and then east from the Peninsular Range of southern California to the Guadalupe Mountains of West Texas. A portion of this region, lying primarily in Nevada and western Utah, is called the Great Basin because all waterways drain internally to dry basins. No streams lying within the Great Basin reach the Pacific Ocean or the Gulf of California.

For much of the Paleozoic (about 550 to 240 million years ago), the region was characterized as a relatively shallow marine environment. Sediments laid down in this marine environment were primarily fine gain carbonates but also included sands and silts. Subsequent metamorphism converted these marine sediments to limestone, sandstone, dolomite, and limited shales.

A hiatus (a period of no geologic record) separates the Paleozoic marine rocks from Early Mesozoic non-marine estuarine and continental sediments. Following deposition of the non-marine sediments, a period of crustal compression occurred in the Late Mesozoic. Evidence of this compressional tectonic regime is displayed as the Keystone Thrust in the Spring Mountains east of the site. Here a large crustal slab of Paleozoic rock has been thrust over a layer of much younger Jurassic sandstone, each crustal slab being many thousands of feet thick (Burchfiel 1974).

Beginning in the Miocene (about 22 million years ago), the Basin and Range province was created as the Earth's crust stretched, thinned, and then broke the metamorphosed rocks into some 400 mountain blocks that partly rotated from their originally horizontal positions (Cook 2004). Normal and strike-slip faulting, as well as associated volcanic activity, transformed the landscape to the basin-and-range type topography typical of the Mojave region today.

Late in the development of the Basin and Range province, and continuing into the Quaternary (the last 2 million years), uplift of the Sierra Nevada, as well as Transverse and Peninsular Ranges of California, led to a strengthened rain shadow and progressive desertification in the Great Basin as precipitation declined in the interior (HHSG 2011a § 5.8).

PROJECT SITE DESCRIPTION

The project site is located in the southern portion of Pahrump Valley, an internally drained basin bound by the Resting Spring and Nopah Ranges on the west and northwest, by the Kingston Range on the southwest, and by the Spring Mountains on the east. Pahrump Dry Lake lies about 3 miles northwest of the HHSEGS site. To the southeast, a low divide separates Pahrump Valley from Sandy Valley while, to the northeast, another low divide separates it from Stewart Valley. To the north, the Last Chance Range separates the Pahrump Valley from the Amargosa Desert. The nearest community to the site is the township of Pahrump, Nevada, which is located approximately 8 miles to the north. The site is bordered by paved Old Spanish Trail Highway (also known as Tecopa Road) to the south, unpaved Quartz Street to the west, the California-Nevada border to the east, and an unpaved road along the northern border. Numerous unpaved roads also extend in a north-south and east-west grid pattern across the site from a 1950's housing subdivision that was never constructed.

The subject property is approximately 3,097 acres in size with a high elevation of approximately 2,675 feet on the east side, and low elevation of approximately 2,585 feet on the west side of the property (Ninyo 2011). The topography across the site is relatively planar to slightly undulatory with a gentle slope from east to west.
The site is undeveloped and covered with sparse native and invasive desert vegetation. This vegetation consists primarily of shrubs and grasses. Existing improvements in the site area include the Old Spanish Trail Highway, which borders the site to the south, and an abandoned peach orchard along the southern property border adjacent to Old Spanish Trail Highway at Silver Road. The abandoned orchard occupies approximately 10 acres, and is presently marked by dead fruit trees, sporadic evergreens and other vegetation. A groundwater well that has recently been serviced is located in the abandoned orchard area.

Several ephemeral (typically dry) drainage washes extend across the eastern portion of the project site, originating in Nevada and flowing westerly into California. Field observations indicate that water runoff generally drains toward the west via sheet-flow and within these natural drainage channels.

As part of the preliminary on-site geotechnical investigation, exploratory borings drilled to maximum depths of 20 feet did not encounter groundwater (Ninyo 2011). During this on-site investigation, four existing nonfunctioning groundwater wells (including the well in the abandoned orchard) were discovered and groundwater levels were measured within the wells. Depth to groundwater in these wells ranged from approximately 110 feet below ground surface (bgs) to 130 bgs (Ninyo 2011).

ASSESSMENT OF IMPACTS AND DISCUSSION OF MITIGATION

This section assesses two types of impacts. The first is the potential impacts the proposed facility could have on existing geologic, mineralogic, and paleontologic resources in the area. The second is the potential geologic hazards, which could adversely affect the proper functioning of the proposed facility and create life/safety concerns.

METHOD AND THRESHOLD FOR DETERMINING SIGNIFICANCE

The California Environmental Quality Act (CEQA) guidelines, Appendix G, provide a checklist of questions that lead agencies typically address when assessing impacts related to geologic and mineralogic resources, and effects of geologic hazards.

- Section (V) (c) includes guidelines that determine if a project will either directly or indirectly destroy a unique paleontological resource or site, or a unique geological feature.

- Sections (VI) (a), (b), (c), (d), and (e) focus on whether or not the project would expose persons or structures to geologic hazards.
- Sections (XI) (a) and (b) concern the project's effects on mineral resources.

To assess potential impacts on unique geologic features and effects on mineral resources, staff has reviewed geologic and mineral resource maps for the surrounding area, as well as site-specific information provided by the applicant, to determine if geologic and mineralogic resources exist in the area (**Geological Resources - Figure 4**).

To assess potential impacts on paleontological resources, staff reviewed existing paleontologic information and reviewed the information obtained from the applicant's requested records searches from the San Bernardino County Museum for the surrounding area. The University of California (at Berkeley) Museum of Paleontology's website, which gives generalized information for locality records of their collection, was consulted as well (UCMP 2008). Site-specific information generated by the applicant for the proposed HHSEGS was also reviewed. All research was conducted in accordance with accepted assessment protocol (BLM 2008 and SVP 1995) to determine whether any known paleontologic resources exist in the general area. If present or likely to be present, conditions of certification which outline required procedures to mitigate adverse affects to potential resources are proposed as part of the project's approval.

The California Building Standards Code (CBSC) and CBC 2010 provide geotechnical and geological investigation and design guidelines, which engineers must follow when designing a facility. As a result, the criterion used to assess the significance of a geologic hazard includes evaluating each hazard's potential impact on the design, construction, and operation of the proposed facility. Geologic hazards include faulting and seismicity, liquefaction, dynamic compaction, hydrocompaction, subsidence, expansive soils, landslides, tsunamis, seiches, and others as may be dictated by site-specific conditions.

DIRECT/INDIRECT IMPACTS AND MITIGATION

An assessment of the potential impacts to geologic, mineralogic, and paleontologic resources, and from geologic hazards is provided below. The assessment of impacts is followed by a summary of potential impacts that may occur during construction and operation of the project and provides recommended conditions of certification that would ensure potential impacts are mitigated to a level that is less than significant. The recommended conditions of certification would allow the Energy Commission's compliance project manager (CPM) and the applicant to adopt a compliance monitoring scheme ensuring ongoing compliance with LORS applicable to geologic hazards and the protection of geologic, mineralogic, and paleontologic resources.

GEOLOGIC AND MINERALOGIC RESOURCES

No known oil or gas reserves were identified to be present in the project vicinity (CDC 2010). There is no indication that oil, gas, or geothermal resources underlie HHSEGS or the surrounding area.

Numerous hard rock mines are located in the hills surrounding the project site. Since the late 1800's, the mines have produced primarily gold, silver and copper (Kral 1951). To the west of the site in the Nopah range, the Shoshone Mines Unit contains a gold-copper bearing porphyry and along with gold and copper has produced lead, zinc, and silver (Dixon 1990). To the northeast near the northern end of Pahrump Valley, in the low hills west of Spring Mountain, lies the Johnnie District. The Johnnie district is noted for its gold-quartz veins and associated gold-placer deposits (Southern 2005). To the southwest of the project site, the Tecopa area is rich in silver. Additional mines to the south-southwest of the site are mined for talc.

The State of California Department of Mines and Geology (now known as the California Geological Survey) uses Mineral Resource Zone (MRZ) classifications to indicate the presence (or lack thereof) of measured or inferred mineral resources on lands across the state. The classifications identified by the CDMG for the HHSEGS project area include MRZ-3b and MRZ-4 (CDMG 1993). These classifications are defined as follows:

MRZ-3b – Areas underlain by inferred mineral occurrence.

MRZ-4 – No known mineral occurrences.

In the vicinity of the project site, MRZ-3b was mapped across the entire Pahrump Valley for "sodium compounds". As stated in SR-167 (CDMG, 1993), these specific resources "have low mineralization density, no production has occurred, and there is a low potential for undiscovered resources." In addition to the MRZ-3b designation, the entire Pahrump Valley area was also mapped as MRZ-4, (no known mineral occurrence), for hydrothermal mineral deposits (gold, silver, copper, lead, and zinc).

Based on the information above, it is staff's opinion that the project would not have any significant adverse direct or indirect impacts to potential geologic and mineralogic resources.

PALEONTOLOGIC RESOURCES

Over at least the last 700,000 years (Middle Pleistocene to Recent), warm-desert environments typical of the present have been the exception rather than the rule (HHSG 2011a § 5.8-7). Interglaciations, like the current Holocene (the last 10,000 years), last for relatively brief periods of time while intervening glaciations typically extend for more than 50,000 years. This is important in considering paleontological resources because, during these extended glacial periods, the project region was occupied by steppe shrubs and coniferous woodlands rather than today's desert scrub (Spaulding 1985; 1990). During these glacial periods, runoff into the valleys formed perennial lakes, increased recharge to local aquifers, raised the water tables, and basin margin artesian spring systems flowed (HHSG 2011a §5.8-9). Pond and marsh environments, and well-vegetated "phreatophyte flats" were commonly associated with discharge from the basin-margin artesian spring systems and, the older the spring, the greater the extent of the spring-fed environments. This is important in considering paleontological resources because these valley bottom riparian habitats attracted now-extinct Pleistocene megafauna, and their remains can be common in some ancient lake (lacustrine) and paleospring sediments (HHSG 2011a §5.8-9). During these glacial periods, perennial lakes were established throughout the Basin Range province. It is likely that similar lakes existed within the Pahrump Valley.

Both lacustrine sediments and paleospring deposits can be fossiliferous. Examples of fossiliferous lacustrine deposits include the fossil beds of Lake Manix and more limited fossil occurrences in the beds of Lake Tecopa (HHSG 2011a §5.8-9). Examples of fossiliferous paleospring deposits include those from Tule Springs in the Las Vegas Valley. The faunal assemblage fossils most often discovered in these deposits are primarily the grazing members of the extinct Pleistocene megafauna including mammoth (Mammuthus columbi), camel (Camelops hesternus), at least two species of horse (Equus spp.), and giant llama (Hemiauchenia sp.) (HHSG 2011a §5.8-9). These fossils are most commonly encountered in the Pleistocene deposits where spring pond sediments are most extensive. While less extensive, fossils in early Holocene deposits would be from near the time of the mass extinction of the Pleistocene megafauna, and therefore, be of critical scientific interest (HHSG 2011a §5.8-9).

The potential for a geologic unit on a site to yield scientifically significant, nonrenewable paleontological resources is referred to as its paleontological sensitivity (SVP 1995). Paleontological sensitivity is a qualitative assessment made by a professional paleontologist taking into account the paleontological potential of the stratigraphic units present, the local geology and geomorphology, and any other local factors that may suggest a probability of encountering fossils. According to the Society of Vertebrate Paleontology standard guidelines, sensitivity comprises (1) the potential for a geological unit to yield abundant or significant vertebrate fossils or for yielding a few significant fossils, large or small, vertebrate, invertebrate, or paleobotanical remains, and (2) the importance of recovered evidence for new and significant taxonomic, phylogenetic, paleoecological, or stratigraphic data (SVP 1995). The Bureau of Land Management (BLM) has developed a potential fossil yield classification system that offers a more detailed system of evaluating the likelihood that a given geological unit may yield fossils (BLM and Chirstensen 2007). This system is described in detail, and also summarized in **Geology and Paleontology Table 2**.

Geology and Paleontology Table 2
SVP Paleontological Sensitivity Ratings (Sensitivity) and Equivalent Potential Fossil Yield Classifications (PFYC) Consistent with BLM Guidelines

Sensitivity (PFYC)	**Definition**
High and Very High (PFYC 4, 5)	Assigned to geological formations known to contain paleontological resources that include rare, well-preserved, and/or fossil materials important to on-going paleoclimatic, paleobiological and/or evolutionary studies. They have the potential to produce, or have produced vertebrate remains that are the particular research focus of many paleontologists, and can represent important educational resources as well.

Geology and Paleontology Table 2
SVP Paleontological Sensitivity Ratings (Sensitivity) and Equivalent Potential Fossil Yield Classifications (PFYC) Consistent with BLM Guidelines

Sensitivity (PFYC)	**Definition**
Moderate and Unknown (PFYC 3a, 3b)	Stratigraphic units that have yielded fossils that are moderately well-preserved, are common elsewhere, and/or that are stratigraphically long-ranging would be assigned a moderate rating. This evaluation can also be applied to strata that have an unproven but strong potential to yield fossil remains based on its stratigraphy and/or geomorphologic setting.
Low (PFYC 2)	Sediment that is relatively recent, or that represents a high-energy subaerial depositional environment where fossils are unlikely to be preserved. A low abundance of invertebrate fossil remains, or reworked marine shell from other units, can occur but the paleontological sensitivity would remain low due to their lack of potential to serve as significant scientific or educational purposes.
Very Low and Zero (PFYC 1)	Stratigraphic units with very low potential include pyroclastic flows and sediments heavily altered by pedogenesis. Most igneous rocks have zero paleontological potential. Other stratigraphic units deposited subaerially in a high energy environment (such as alluvium) may also be assigned a marginal or zero sensitivity rating. Manmade fill is also considered to possess zero (no) paleontological potential.

Source: HHSEGS 2011

The results of a records search conducted by San Bernardino County Museum suggested that paleolake or paleospring sediments might be widespread across the site (HHSG 2011a, Appendix 5.8A). In an attempt to evaluate the likelihood of project development to impact paleontological resources during site excavations, the applicant's Paleontological Resources Specialist (PRS) conducted an initial 5 day long site survey followed by a day of monitoring the excavation of 10 geotechnical test pits in the project area (HHSG 2011a §5.8-10).

The site survey focused on areas of high albedo (white and near-white) which comprise exposures of the older, fine-grained and carbonate-rich basin fill material. During the site survey, a number of bleached bone fragments were located but these proved upon testing to be recent. No mineralized bone (suggestive of fossilization) was discovered. Tufa nodules (formed by spring discharge) were commonly discovered as lag concentrate in some areas, and at least one tufa ledge was noted. However, no direct evidence of ground water discharge (paleosprings) was located on the site. No paleontological resources were found during the surficial survey (HHSG 2011a §5.8-10).

In addition to the site survey, backhoe test pit excavations and spoils were monitored to check for fossil material encountered and to identify sediment at depth that might possess high paleontological sensitivity. During the initial survey and subsequent field investigation, it was noted that a blanket of Holocene, alluvial silty sand appears to mantle older, more indurated, carbonate-rich, light-colored silty clay to clayey sand. The older sediments display strong soil development at depth, and are likely of Pleistocene age (HHSG 2011a §5.8-9).

The stratigraphy of soils exposed in the geotechnical test pits appears consistent with a model of recent (post-Pleistocene and likely late Holocene), sandy alluvium encroaching from the east and covering an older surface, which may be of Pleistocene age (HHSG 2011a §5.8-10). Gastropod shells, bone fragments, relatively well-sorted gravel lenses, and carbonized wood are indicators of paleospring deposits, but none were encountered in the test pits.

No paleontological resources, or records of previous fossil finds, were found within one mile of the HHSEGS and no paleontological resources were encountered during the excavation of the geotechnical test pits.

Based on the absence of discovering paleontological resources while monitoring geotechnical test pit excavations, conducting pedestrian surveys of areas where fine-grained, carbonate-rich sediment is exposed at the surface, and repeated survey of the most promising areas by the project PRS, the applicant concluded that the alluvium of the project area is considered to possess low paleontological sensitivity (PFYC 2) (HHSG 2011a, §5.8-6).

While the applicant considers the likelihood of encountering paleontological resources during construction to be low, significant paleontological resources associated with subsurface lacustrine deposits and paleospring environments have been discovered in the region (HHSG 2011a, Appendix 5.8A). Paleosprings have been identified along the Stateline fault to the east of the site, and it is likely that water emanating from those springs flowed across the site. Depending on the ancient volume and rate of flow, paleospring deposits could exist beneath the site.

In the “Paleontology Literature and Records Review” conducted by the San Bernardino County Museum (SBCM) for this project, it was stated that “excavation into undisturbed subsurface lake and/or spring sediments in the Pahrump Valley has a high potential to impact significant paleontologic resources” (HHSG 2011a, Appendix 5.8A). The SBCM review recommended monitoring of excavation in areas identified as likely to contain paleontologic resources. Staff concurs with this recommendation. Therefore, staff considers monitoring of construction activities in accordance with the proposed conditions of certification is necessary. Proposed Conditions of Certification **PAL-1** to **PAL-7** are designed to mitigate any potential paleontological resource impacts, as discussed above, to a less than significant level. Essentially, these conditions would require a worker education program in conjunction with monitoring of proposed earthwork activities by qualified professional paleontologists (paleontologic resource specialist; PRS). Staff believes these conditions would also address the intent of the Inyo County General Plan, which places emphasis on the preservation of historic and prehistoric resources and values (HHSG 2011a §5.8-15).

Earthwork would be halted in the immediate area of the find at any time potential fossils are recognized by either the paleontological monitor or the worker. When properly implemented, the conditions of certification would yield a net gain to the science of paleontology since fossils that would not otherwise have been discovered can be collected, identified, studied, and properly curated. A paleontological resource specialist would be retained for the proposed project by the applicant to produce a monitoring and mitigation plan, conduct the worker training, and provide the on-site monitoring. During the monitoring, the PRS can petition the Energy Commission for a change in the monitoring protocol. Most commonly, this would be a request for lesser monitoring after sufficient monitoring has been performed to ascertain that there is little chance of finding significant fossils. In other cases, the PRS can propose increased monitoring due to unexpected fossil discoveries or in response to repeated out-of-compliance incidents by the earthwork contractor.

Based on the information above, it is staff’s conclusion that the project would not have any significant adverse direct or indirect impacts to paleontological resources.

GEOLOGICAL HAZARDS

The AFC provides documentation of potential geologic hazards at the proposed HHSEGS plant site (HHSG 2011a §5-4). Review of the AFC, coupled with staff’s independent research, indicates that the possibility of geologic hazards at the plant site, during its practical design life, would be low. However, geologic hazards, such as potential for strong seismic shaking, subsidence (including ground fissuring), expansive clay soils and settlement due to hydrocompaction, compressible soils and dynamic compaction, would need to be addressed in a project geotechnical report per CBC 2010 requirements.

Staff’s independent research included the review of available geologic maps, reports, and related data of the proposed HHSEGS plant site. Geological information from the California Geological Survey (CGS), California Division of Mines and Geology (CDMG), and other governmental organizations was reviewed. Staff’s analysis of this information is provided below.

Faulting and Seismicity

The HHSEGS site is located in southwestern California in an area that is tectonically dominated by translational slippage between the North American and Pacific crustal plates. On a broad scale, the North American-Pacific tectonic plate boundary in California is a transform shear that extends from the Gulf of California to Cape Mendocino. The width of shear extends from the eastern border of California and into western Nevada, to several miles west of the coast of California. Traversing the length of California, the San Andreas fault zone is the most noteworthy of the fault zones within this transform shear boundary. Fully 60 percent of the relative plate motion occurs along the San Andreas fault zone (Faulds 2008). The remainder of the shear is taken up by the associated faults within this plate boundary. With increasing distance west of the San Andreas, the continental crust (and the faults contained within it) becomes more a part of the Pacific plate and shares its northwesterly absolute motion. With increasing distance east of the San Andreas, the continental crust (and the faults contained within it) becomes more a part of the North American plate and shares its southeasterly absolute motion.

The area of faulting to the east of the San Andreas is referred to as the Eastern California shear zone (Guest 2007). The Eastern California shear zone is an important component of the Pacific–North America plate boundary. This region of active, predominantly strike-slip, deformation extends from the southern Mojave Desert along the east side of the Sierra Nevada and into western Nevada. The Eastern California Shear Zone is thought to accommodate nearly a quarter (10 to 12 mm/yr) of relative plate motion between the Pacific and North America plates (Frankel 2008).
The project site lies within the Eastern California Shear Zone (ECSZ). Named faults within the ECSZ in the project vicinity include from west to east, the Owens Valley, Panamint Valley, Death Valley and Stateline fault zones (**Geological Resources - Figure 2**).

The Owens Valley fault, located along the western boundary of the ECSZ traverses the central part of the Owens Valley, extending 100 km from the northern shore of Owens Lake to just north of Big Pine. The fault exhibits impressive strike-slip geomorphic features, including pressure ridges, sag ponds, echelon scarps, vegetation lineaments, fault scarps, and groundwater barriers (Beanland 1994).

The Southern Panamint Valley fault zone is delineated by well-defined geomorphic evidence characteristic of both dextral strike-slip and normal dip-slip displacement along north to northwest-striking faults. The Southern Panamint Valley fault zone is delineated by two or more parallel traces. The eastern traces are characterized by geomorphic features indicative of normal dip-slip offset such as well-defined scarps on latest Pleistocene and Holocene alluvial fans along the prominent west-facing bedrock range front, vertically offset drainages, and faceted spurs (Bryant 1989). Western traces are delineated by geomorphic features indicative of Holocene strike-slip offset such as deflected drainages, linear ridges, side hill benches, closed depressions, ponded alluvium, and well-defined linear scarps on Holocene alluvium, linear toughs, and linear tonal contrasts on Holocene alluvium (Bryant 1989).

The Southern Death Valley fault zone is characterized by oblique slip, with a lateral component of a few hundred meters. Movement along these traces has formed normal faults and gentle-to-isoclinal folds that have uplifted fan gravel and lacustrine sediments as much as 200 m above the modern alluvial fan surface.

The Stateline Fault forms the eastern boundary of the ECSZ and marks the transition from stable North America to its mobile western margin (Guest 2007, Hislop, 2011). This 200 km long fault system lies just east of the project site (**Geological Resources - Figure 1**). Recent geologic mapping has documented approximately 30 km of dextral offset along the fault over approximately the last13 thousand years, which translates to a minimum long-term geologic slip rate of approximately 2.5 mm/year (Guest 2007). Understanding the spatial and temporal evolution of the Stateline Fault is important for seismic hazard assessment in the region and for use in models describing the development of the ECSZ.

The segment of the Stateline fault within the project area is referred to as the Pahrump Valley fault zone (Shields 1997). The Pahrump Valley fault zone (PVFZ) is active and represents a potential seismic hazard for the region. The PVFZ is the longest seismogenic structure within 100 km of the Pahrump area. Additional segments of the PVFZ extend north through Stewart Valley into Ash Meadows and the southern Amargosa Desert (Shields 1997). To the south, it extends through Mesquite Valley and possibly into Sandy and even Ivanpah Valleys (Louie 1997). Combining as many as six segments over a total length of more than 100 km, the PVFZ may be able to produce a magnitude 7 event (Louie 1997, Shields 1997).

In southern Pahrump Valley, the PVFZ divides into three fault-line scarps, each dissected by headward erosion of the uplifted playa and alluvial surfaces (Anderson 1998). These scarps are located approximately 2,000, 4,000, and 5,000 meters northeast from the center of the site. The scarp closest to the site has the sharpest features and is geomorphically the youngest scarp, with about 10 m of relief. The scarps further east from the site are about twice as high, have gentler slopes and appear more eroded. Their subdued geomorphic expression indicates they are older and their last scarp forming earthquake occurred previous to that of the westernmost scarp.

The Alquist-Priolo Earthquake Fault Zoning Act of 1994 (formerly known as the Alquist-Priolo Special Studies Zone Act of 1972) stipulates that no structure for human occupancy may be built within an Earthquake Fault Zone until geologic investigations demonstrate that the site is free of fault traces that are likely to rupture with surface displacement. Earthquake Fault Zones include faults considered to have been active during Holocene time and to have a relatively high potential for surface rupture (CGS 2008). No active faults are shown on published maps as crossing the boundary of new construction on the proposed HHSEGS power plant site or associated linear facilities. Similar to the rest of southern California, the project vicinity has a number of sources of seismicity. One of the largest historical earthquakes in California (estimated Mw 7.5), occurred in 1872 along the Owens Valley fault, approximately 130 miles northwest of the site.

There have been two significant earthquakes in the region within the last 15 years. The 1992 Landers event ruptured along a series of faults in the central portion of the Eastern California Shear Zone, about 124 miles southwest of the project site. This moment magnitude (Mw) 7.3 event was accompanied by significant ground rupture, with over 18 feet of slip noted at certain locations, and over 3 feet of slip noted over 53 miles of the rupture. In 1999, less than 7 years later, a Mw 7.1 event occurred on the Bullion and Lavic Lake faults (referred to as the Hector Mine Earthquake). These events were located approximately 98 miles to the southwest of the project site. The overall length of ground rupture has been estimated at 28 miles with significant slip (greater than an inch or so) occurring over a distance of about 22 miles. Maximum displacement was estimated at 17 feet of right slip and an average slip of approximately 8 to 10 feet. Preliminary estimates of ground motion based on probabilistic seismic hazard analyses have been calculated for the project site using the USGS Earthquake Hazards application called the U.S. Seismic “DesignMaps” Web Application (**Geology and Paleontology Table 3**). This application produces seismic hazard curves, uniform hazard response spectra, and seismic design values. The values provided by this application are based upon data from the 2008 USGS National Seismic Hazard

Mapping Project. These design parameters are for use with the 2012 International Building Code, the 2010 ASCE-7 Standard, the 2009 NEHRP Provisions, and their respective predecessors.

These parameters are project-specific and, based on HHSEGS's location, were calculated using latitude and longitude inputs of 35.985 degrees north and 115.901 degrees west, respectively. Other inputs for this application are the site "type" which is based on the underlying geologic materials and the "Structure Risk Category". The assumed site class for HHSEGS is "D", which is applicable to stiff soil. These parameters can be updated as appropriate following the results presented in a project-specific geotechnical investigation report performed for the site. The assumed "Structure Risk Category" is "III", which is based on its inherent risk to people and the need for the structure to function following a damaging event. Risk categories range from I (non essential) to IV (critical). Examples of risk category I include agriculture facilities, minor storage facilities, etc., while examples of category IV include fire stations, hospitals, nuclear power facilities, etc.

The ground acceleration values presented are typical for the area. Other developments in the adjacent area will also be designed to accommodate strong seismic shaking. The potential for and mitigation of the effects of strong seismic shaking during an earthquake should be addressed in a project-specific geotechnical report, per CBC 2010 requirements, and proposed **FACILITY DESIGN CONDITIONS OF CERTIFICATION GEN-1**, **GEN-5** and **CIVIL-1**. Compliance with these conditions of certification would ensure the project is built to current seismic standards and potential impacts would be mitigated to insignificant levels in accordance with current standards of engineering practice.

Geology and Paleontology Table 3
PLANNING LEVEL 2010 CBC SEISMIC DESIGN PARAMETERS MAXIMUM CONSIDERED EARTHQUAKE, ASCE 7 STANDARD

Parameter	Value
Assumed Site Class	D
Structure Risk Category	III - Substantial
SS – Mapped Spectral Acceleration, Short (0.2 Second) Period	0.484 g
S1 – Mapped Spectral Acceleration, Long (1.0 Second) Period	0.198 g
Fa – Site Coefficient, Short (0.2 Second) Period	1.413
Fv – Site Coefficient, Long (1.0 Second) Period	2.009
SDS – Design Spectral Response Acceleration, Short (0.2 Second) Period	0.456 g
SD1 – Design Spectral Response Acceleration, Long (1.0 Second) Period	0.265 g
SMS – Spectral Response Acceleration, Short (0.2 Second) Period	0.684 g
SM1 – Spectral Response Acceleration, Long (1.0 Second) Period	0.397 g

ASCE = American Society of Civil Engineers
Values from USGS 2010b

Liquefaction

Liquefaction is a phenomenon whereby loose, saturated, granular soils lose their inherent shear strength because of excess pore water pressure build-up, such as that generated during repeated cyclic loading from an earthquake. A low relative density of the granular materials, shallow groundwater table, long duration, and high acceleration of seismic shaking are some of the factors favorable to cause liquefaction.

The presence of predominantly cohesive or fine-grained materials and/or absence of saturated conditions can preclude liquefaction. Liquefaction hazards are usually manifested in the form of buoyancy forces during liquefaction, increase in lateral earth pressures due to liquefaction, horizontal and vertical movements resulting from lateral spreading, and post-earthquake settlement of the liquefied materials.

The depth to ground water on the proposed HHSEGS site is approximately 130 feet below ground surface (HHSG 2011a §5.15-12). Based on site observations and review of information presented in the preliminary geotechnical report (Ninyo 2011), subsurface conditions at the site are not likely to be conducive to liquefaction. However, ground water levels should be confirmed, and the liquefaction potential on the proposed HHSEGS site should be addressed in a project-specific geotechnical report, per CBC 2010 requirements and proposed **FACILITY DESIGN CONDITIONS OF CERTIFICATION GEN-1**, **GEN-5** and **CIVIL-1**.

Lateral Spreading

Lateral spreading of the ground surface can occur within liquefiable beds during seismic events. Lateral spreading generally requires an abrupt change in slope, such as a nearby steep hillside or deeply eroded stream bank, but can also occur on gentle slopes. Other factors such as distance from the epicenter, magnitude of the seismic event, and thickness and depth of liquefiable layers also affect the amount of lateral spreading. The HHSEGS site is underlain by predominantly unsaturated, cohesive, fine-grained materials that are not typically associated with liquefaction. However, ground water levels should be confirmed and the liquefaction potential of underlying beds beneath the proposed HHSEGS site should be addressed in a project-specific geotechnical report, per CBC 2010 requirements and proposed **FACILITY DESIGN CONDITIONS OF CERTIFICATION GEN-1, GEN-5** and **CIVIL-1**.

Dynamic Compaction

Dynamic compaction of soils results when relatively unconsolidated granular materials experience vibration associated with seismic events. The vibration causes a decrease in soil volume, as the soil grains tend to rearrange into a more dense state (an increase is soil density). The decrease in volume can result in settlement of overlying structural improvements.

The potential for and mitigation of the effects of dynamic compaction of proposed site native and fill soils during an earthquake should be addressed in a project-specific geotechnical report, per CBC 2010 requirements and proposed **FACILITY DESIGN CONDITIONS OF CERTIFICATION GEN-1**, **GEN-5** and **CIVIL-1**. Common mitigation methods would include deep foundations (driven piles; drilled shafts) for severe conditions, geogrid reinforced fill pads for moderate severity and over-excavation and replacement for areas of minimal hazard.

Hydrocompaction

Hydrocompaction (also known as hydro-collapse) is generally limited to young soils that were deposited rapidly in a saturated state, most commonly by a flash flood. The soils dry quickly, leaving an unconsolidated, low density deposit with a high percentage of voids. Foundations built on these types of compressible materials can settle excessively, particularly when landscaping irrigation dissolves the weak cementation that is preventing the immediate collapse of the soil structure. As stated in the preliminary geotechnical report, “some of the encountered native soils were slightly too moderately gypsiferous and slightly too highly porous, with poreholes up to approximately 1/4-inch in diameter” (Ninyo 20011). Conclusions in the preliminary geotechnical report suggest site soils are subject to a high collapse potential and should be considered unsuitable for support of structures and improvements in their existing condition (Ninyo 2011). The potential for and mitigation of the effects of hydrocompaction of site soils should be addressed in a project-specific geotechnical report, per CBC 2010 requirements and proposed **FACILITY DESIGN CONDITIONS OF CERTIFICATION GEN-1**, **GEN-5** and **CIVIL-1**. Typical mitigation measures would include over-excavation/replacement, mat foundations or deep foundations, depending on severity and foundation loads.

Subsidence

Local subsidence or settlement may occur when areas containing compressible soils are subjected to foundation loads. Conclusions presented in the preliminary geotechnical report indicate surficial soils have high porosity. These soils are considered to be prone to settlement and should be considered unsuitable for support of structures and improvements in their existing condition (Ninyo 2011).

Settlement can also occur in poorly consolidated soils during ground shaking. Earthquake-induced settlement can cause distress to structures supported on shallow foundations, damage to utilities that serve pile-supported structures, and damage to utility lines that are commonly buried at shallow depths (Kramer 1996). During settlement, the soil materials are physically rearranged by the shaking to result in a less stable alignment of the individual grains. Settlement of sufficient magnitude to cause significant structural damage is normally associated with rapidly deposited alluvial soils, or improperly founded or poorly compacted fill.

Within the project vicinity, the greatest subsidence hazard is posed by the occurrence of earth fissures. Earth fissures are surface expressions of deep fracture systems typically caused by groundwater withdrawal that exceeds aquifer recharge (Snelson 2005). Generally, the surface expressions of earth fissures are not identified until surface flows from flash flooding or over-watering enter the fissure causing erosion of the fissure sidewalls. These ground failures can be exacerbated by faults at depth, shallow bedrock, and/or differential compaction (Snelson 2005).

Earth fissures can be up to several feet wide and deep, and thousands of feet long. The initial stage of development of the earth fissure is a narrow crack in the soil, which forms due to tensional forces sometimes related to groundwater withdrawal and associated land subsidence. Erosion processes, such as gullying and subsurface water migration during periods of heavy runoff, widen and deepen the crack into a ground fissure. Due to underground erosion, or piping, tunnel-like features and other subsurface voids form along the ground cracks. When the soils above the voids erode and collapse, sinkholes, linear depressions, and/or trench-like features occur at the ground surface.

Earth fissures have been documented within the Pahrump Valley and have been responsible for significant damage to structures in the city of Pahrump (dePolo 1999). It is believed that subsidence in these areas is likely related to groundwater overdraft. These fissures could be exacerbated by both surface and groundwater flow and by local seismicity.

The nearest mapped ground fissure zone is located approximately 8 miles north of the project site. Ground lineations in Pahrump Valley sediments, which may be indicative of ground fissuring, were also noted approximately 2 miles west and 6 miles northwest of the project site (dePolo 2003).

During site reconnaissance associated with the preliminary geotechnical evaluation, numerous ground surface lineations, which appear to have been caused by ground fissures, were identified (Ninyo 2011). These lineations ranged from a few inches to several feet wide and were up to hundreds of yards long. The lineations generally extended in north-south and northwest-southeast directions across the site. The lineations were observed to be associated with an increase in vegetation, eroded or loose soil, relatively slight depressions in the ground surface, and, in a few areas, ground cracks up to approximately 2 inches wide and a few inches deep (Ninyo 2011).

The potential for and mitigation of the effects of subsidence of site soils should be addressed in a project-specific geotechnical report, per CBC 2010 requirements and proposed **FACILITY DESIGN CONDITIONS OF CERTIFICATION GEN-1**, **GEN-5** and **CIVIL-1**. Typical mitigation measures would include over-excavation/replacement, mat foundations or deep foundations, depending on severity and foundation loads. Precipitation runoff control should be utilized to prevent infiltration of surface water into existing or suspected earth fissure areas. Analysis of and mitigation for subsidence potential caused by groundwater withdrawal is presented in the Water Resources and Supply section of this document.

Expansive Soils

Soil expansion occurs when clay-rich soils with an affinity for water exist in-place at a moisture content below their plastic limit. The addition of moisture from irrigation, precipitation, capillary tension, water line breaks, etc. causes the clay soils to absorb water molecules into their structure, which in turn causes an increase in the overall volume of the soil. This increase in volume can correspond to excessive movement (heave) of overlying structural improvements. The potential for and mitigation of the effects of expansive soils on the proposed site should be addressed in a project-specific geotechnical report, per CBC 2010 requirements and proposed **FACILITY DESIGN CONDITIONS OF CERTIFICATION GEN-1**, **GEN-5** and **CIVIL-1**. Mitigation would normally be accomplished by over-excavation and replacement of the expansive soils.

For deep-seated conditions, deep foundations are commonly used. Lime-treated (chemical modification) is often used to mitigate expansive clays in pavement areas.

Landslides

Landslides occur when masses of rock, earth, or debris move down a slope, including rock falls, deep failure of slopes, and shallow debris flows. Landslides are influenced by human activity (mining and construction of buildings, railroads, and highways) and natural factors (geology, precipitation, and topography). Frequently, they accompany other natural hazards. Although landslides sometimes occur during earthquake activity, earthquakes are rarely their primary cause.

The most common cause of a landslide is an increase in the down slope gravitational stress applied to slope materials (oversteepening). This may be produced either by natural processes or human activities. Undercutting of a valley wall by stream erosion is a common way in which slopes may be naturally oversteepened. Other ways include excessive rainfall or irrigation on a cliff or slope.

The site is relatively flat and located substantial distances from steep terrain. Therefore, the site is not subject to landslide hazards.

Tsunamis and Seiches

Tsunamis are large-scale seismic-sea waves caused by offshore earthquakes, landslides and/or volcanic activity. Seiches are waves generated within enclosed water bodies such as bays, lakes or reservoirs caused by seismic shaking, rapid tectonic uplift, basin bottom displacement and/or land sliding. The proposed power plant site is located approximately 200 miles inland from the coast. There is no water bodies located at an elevation above the project site within the project vicinity. Therefore, the site is not subject to either tsunami of seiche hazards. For further analysis see the **SOIL RESOURCES AND WATER RESOURCES** sections.

The design-level geotechnical investigation required for the proposed project by the CBC 2010 and proposed **FACILITY DESIGN CONDITIONS OF CERTIFICATION GEN-1**, **GEN-5** and **CIVIL-1** should provide standard engineering design recommendations for mitigation of seismic shaking, ground subsidence (including fissuring), expansive clay soils, liquefaction and excessive settlement due to compressible soils or dynamic compaction, as appropriate.

OPERATION IMPACTS AND MITIGATION

Operation of the proposed plant facilities should not have any adverse impact on geologic, mineralogic, or paleontologic resources. Once the plant is constructed and operating, there would be no further disturbances that could affect these resources. Potential geologic hazards, including strong ground shaking, ground subsidence (including fissuring), liquefaction settlement due to compressible soils, hydrocompaction, or dynamic compaction, and the possible presence of expansive clay soils can be effectively mitigated through facility design such that these potential hazards should not affect future operation of the facility. Compliance with **CONDITIONS OF CERTIFICATION GEN-1, GEN-5** and **CIVIL-1** in the **FACILITY DESIGN** section of this **FSA** would ensure the project is constructed to current seismic building standards and potential impacts would be mitigated in accordance with current standards of engineering practice.

CUMULATIVE IMPACTS AND MITIGATION

No geologic and mineralogic resources have been identified in the project area. The site has not been identified as containing a significant mineral deposit that should be protected and is several miles from the closest identified mineral resource (hard rock mines). Development of this project is not expected to lead to a significantly cumulative effect on geologic and mineralogic resources within the project area.

Paleontological resources have been documented in the general area of the proposed project and in sediments similar to those that are present on the site. However, to date, none have been found on the plant site or along project linear routes within California during cursory field studies of the HHSEGS. If significant paleontological resources are uncovered during construction they would be protected and preserved in accordance with **CONDITIONS OF CERTIFICATION PAL-1** to **PAL-7**. These conditions would also mitigate any potential cumulative impacts.

The proposed HHSEGS would be situated in an active geologic environment. Strong ground shaking potential must be mitigated through foundation and structural design as required by the CBC 2010. The potential for ground subsidence and fissuring must be addressed and mitigated through appropriate facility design. Expansive materials, as well as compressible soils and soils that may be subject to settlement due to dynamic compaction, must be addressed and mitigated in accordance with a design-level geotechnical investigation as required by the CBC 2010, and proposed **CONDITIONS OF CERTIFICATION GEN-1**, **GEN-5**, and **CIVIL-1** under the **FACILITY DESIGN** section of this **FSA.**

FACILITY CLOSURE

Future facility closure activities would not be expected to impact geologic or mineralogic resources since no such resources are known to exist at either the project location or along its proposed linears. In addition, the decommissioning and closure of the proposed project should not negatively affect geologic, mineralogic, or paleontologic resources since the majority of the ground disturbed during plant decommissioning and closure would have been already disturbed, and mitigated as required, during construction and operation of the project.

RESPONSE TO AGENCY AND PUBLIC COMMENTS

Staff has not received any agency or public comments regarding geologic hazards, geologic or mineral resources, or paleontology at this time. However, Preliminary Staff Assessment (PSA) comments were received from the applicant, BrightSource Energy. These PSA Response to Comments can be reviewed in **Appendix 1**.

PROPOSED FINDINGS OF FACT

Based on our analysis of the project, we propose the following findings:

1. Several northwest-striking active and potentially active faults are present in the project area.

2. Since no active faults are known to cross the boundary of new construction at the project site, the project is not subject to the set-back requirements mandated by the Alquist-Priolo Special Studies Zone Act.

3. The primary geologic hazards that could affect the project include strong earthquake-related ground shaking and ground subsidence caused by earth fissuring and possibly from groundwater withdrawal.

4. **CONDITIONS OF CERTIFICATION GEN-1**, **GEN-4**, **GEN-5**, and **CIVIL-1** of the **FACILITY DESIGN** section require the project owner to conduct a site-specific geotechnical investigation, which confirms the soil profile, including composition and depth of fill materials as well as subsurface information such as groundwater depth and the location of expansive clays beneath the project footprint, before project design can be finalized.
5. **CONDITIONS OF CERTIFICATION GEN-1**, **GEN-4**, **GEN-5**, and **CIVIL-1** of the **FACILITY DESIGN** section require the project owner to design the project to current engineering standards to ensure that potential geologic hazards to the project will be adequately mitigated.

6. The evidence assumes that liquefaction, lateral spreading, dynamic compaction, landslides, flooding, tsunamis, and seiches pose low or negligible project risks but this assumption must be confirmed by the site-specific geotechnical investigation referenced in **FINDINGS #4** and **#5.**

7. There is no evidence of existing or potential geologic or mineralogic resources at the project site or along the linear alignments.

8. Although many paleontologic sites are documented within three miles of the site, there are no records documenting paleontologic finds on the HHSEGS site or along the project's linear alignments.

9. Any potential impacts to newly discovered paleontologic resources during excavation and construction, will be mitigated to a level of less than significant by the project owner's implementation of a Paleontological Monitoring and Mitigation Plan, including a Worker Environmental Awareness Program, and employ an on-site Paleontologic Resource Specialist with authority to halt construction activities when paleontologic resources are identified.

10. There is no evidence that project construction or operation will result in cumulative impacts to geologic, mineralogic, or paleontologic resources.

CONCLUSIONS

The applicant would be able to comply with applicable LORS, provided that the proposed conditions of certification are followed. The proposed design and construction of the project should have no adverse impact with respect to geologic, mineralogic, and paleontologic resources. Staff proposes to ensure compliance with applicable LORS through the adoption of the proposed conditions of certification listed below.

It is staff's opinion that the likelihood of encountering paleontologic resources would be high in areas where lacustrine and paleospring deposits occur. Staff would consider reducing monitoring intensity, at the recommendation of the project PRS, following examination of sufficient, representative excavations to fully understand site stratigraphy.

PROPOSED CONDITIONS OF CERTIFICATION

General Conditions of Certification with respect to engineering geology are proposed under Conditions of Certification **GEN-1, GEN-5**, and **CIVIL-1** in the **FACILITY DESIGN** section. Proposed paleontological Conditions of Certification **PAL-1** through **PAL-7** follow.

PAL-1 The project owner shall provide the compliance project manager (CPM) with the resume and qualifications of the proposed Paleontological Resource Specialist (PRS) for review and approval. If the approved PRS is replaced prior to completion of project mitigation and submittal of the Paleontological Resources Report, the project owner shall obtain CPM approval of a replacement PRS. The project owner shall keep resumes on file for qualified Paleontological Resource Monitors (PRMs). If a PRM is replaced, the resume of the replacement PRM shall also be provided to the CPM for review and approval.

The PRS resume shall include the names and phone numbers of references. The resume shall also demonstrate to the satisfaction of the CPM the appropriate education and experience to accomplish the required paleontological resource tasks.

As determined by the CPM, the PRS shall meet the minimum qualifications for a vertebrate paleontologist as described in the Society of Vertebrate Paleontology (SVP) guidelines of 1995. The experience of the PRS shall include the following:

1. Institutional affiliations, appropriate credentials, and college degree;
2. Ability to recognize and collect fossils in the field;
3. Local geological and biostratigraphic expertise;
4. Proficiency in identifying vertebrate and invertebrate fossils; and

5. At least three years of paleontological resource mitigation and field experience in California and at least one year of experience leading paleontological resource mitigation and field activities.

The project owner shall ensure that the PRS obtains qualified paleontological resource monitors to monitor as the PRS deems necessary on the project. Paleontologic Resource Monitors (PRMs) shall have the equivalent of the following qualifications:

- BS or BA degree in geology or paleontology and one year of experience monitoring in California; or
- AS or AA in geology, paleontology, or biology and four years' experience monitoring in California; or
- Enrollment in upper division classes pursuing a degree in the fields of geology or paleontology and two years of monitoring experience in California.

Verification: (1) At least 60 days prior to the start of ground disturbance, the project owner shall submit a resume and statement of availability of its designated PRS for on-site work.

(2) At least 20 days prior to ground disturbance, the PRS or project owner shall provide a letter with resumes naming anticipated monitors for the project, stating that the identified monitors meet the minimum qualifications for paleontological resource monitoring required by the condition. If additional monitors are obtained during the project, the PRS shall provide additional letters and resumes to the CPM. The letter shall be provided to the CPM no later than one week prior to the monitor's beginning on-site duties.

(3) Prior to the termination or release of a PRS, the project owner shall submit the resume of the proposed new PRS to the CPM for review and approval.

PAL-2 The project owner shall provide to the PRS and the CPM, for approval, maps and drawings showing the footprint of the power plant, construction lay down areas, and all related facilities. Maps shall identify all areas of the project where ground disturbance is anticipated. If the PRS requests enlargements or strip maps for linear facility routes, the project owner shall provide copies to the PRS and CPM. The site grading plan and plan and profile drawings for the utility lines would be acceptable for this purpose. The plan drawings should show the location, depth, and extent of all ground disturbances and be at a scale between 1 inch = 40 feet and 1 inch = 100 feet range. If the footprint of the project or its linear facilities change, the project owner shall provide maps and drawings reflecting those changes to the PRS and CPM.

If construction of the project proceeds in phases, maps and drawings may be submitted prior to the start of each phase. A letter identifying the proposed schedule of each project phase shall be provided to the PRS and CPM. Before work commences on affected phases, the project owner shall notify the PRS and CPM of any construction phase scheduling changes.

At a minimum, the project owner shall ensure that the PRS or PRM consults weekly with the project superintendent or construction field manager to confirm area(s) to be worked the following week, and until ground disturbance is completed.

Verification: At least 30 days prior to the start of ground disturbance, the project owner shall provide the maps and drawings to the PRS and CPM.

If there are changes to the footprint of the project, revised maps and drawings shall be provided to the PRS and CPM at least 15 days prior to the start of ground disturbance.

If there are changes to the scheduling of the construction phases, the project owner shall submit a letter to the CPM within 5 days of identifying the changes.

PAL-3 The project owner shall ensure that the PRS prepares, and the project owner submits to the CPM for review and approval, a paleontological resources monitoring and mitigation plan (PRMMP) to identify general and specific measures to minimize potential impacts to significant paleontological resources. Approval of the PRMMP by the CPM shall occur prior to any ground disturbance. The PRMMP shall function as the formal guide for monitoring, collecting, and sampling activities, and may be modified with CPM approval. This document shall be used as the basis of discussion when on-site decisions or changes are proposed. Copies of the PRMMP shall reside with the PRS, each monitor, the project owner's on-site manager, and the CPM.

The PRMMP shall be developed in accordance with the guidelines of the Society of Vertebrate Paleontology (SVP, 1995) and shall include, but not be limited, to the following:

1. Assurance that the performance and sequence of project-related tasks, such as any literature searches, pre-construction surveys, worker environmental training, fieldwork, flagging or staking, construction monitoring, mapping and data recovery, fossil preparation and collection, identification and inventory, preparation of final reports, and transmittal of materials for curation will be performed according to PRMMP procedures;

2. Identification of the person(s) expected to assist with each of the tasks identified within the PRMMP and the conditions of certification;

3. A thorough discussion of the anticipated geologic units expected to be encountered, the location and depth of the units relative to the project when known, and the known sensitivity of those units based on the occurrence of fossils either in that unit or in correlative units;

4. An explanation of why, how, and how much sampling is expected to take place and in what units. Include descriptions of different sampling procedures that shall be used for fine-grained and coarse-grained units;

5. A discussion of the locations of where the monitoring of project construction activities is deemed necessary, and a proposed plan for monitoring and sampling;

6. A discussion of procedures to be followed in the event of a significant fossil discovery, halting construction, resuming construction, and how notifications will be performed;

7. A discussion of equipment and supplies necessary for collection of fossil materials and any specialized equipment needed to prepare, remove, load, transport, and analyze large-sized fossils or extensive fossil deposits;

8. Procedures for inventory, preparation, and delivery for curation into a retrievable storage collection in a public repository or museum, which meet the Society of Vertebrate Paleontology's standards and requirements for the curation of paleontological resources;

9. Identification of the institution that has agreed to receive data and fossil materials collected, requirements or specifications for materials delivered for curation, and how they will be met, and the name and phone number of the contact person at the institution; and

10. A copy of the paleontological conditions of certification.

Verification: At least 30 days prior to ground disturbance, the project owner shall provide a copy of the PRMMP to the CPM for review and approval. The PRMMP shall include an affidavit of authorship by the PRS, and acceptance of the PRMMP by the project owner evidenced by a signature.

PAL-4 Prior to ground disturbance and for the duration of construction activities involving ground disturbance, the project owner and the PRS shall prepare and conduct weekly CPM-approved training for the following workers: project managers, construction supervisors, foremen and general workers involved with or who operate ground-disturbing equipment or tools. Workers shall not excavate in sensitive units prior to receiving CPM-approved worker training. Worker training shall consist of an initial in-person PRS training during the project kick-off, for those mentioned above. Following initial training, a CPM-approved video or in-person training may be used for new employees. The training program may be combined with other training programs prepared for cultural and biological resources, hazardous materials, or other areas of interest or concern. No ground disturbance shall occur prior to CPM approval of the Worker Environmental Awareness Program (WEAP), unless specifically approved by the CPM.

The WEAP shall address the possibility of encountering paleontological resources in the field, the sensitivity and importance of these resources, and legal obligations to preserve and protect those resources.

The training shall include:

1. A discussion of applicable laws and penalties under the law;

2. Good quality photographs or physical examples of vertebrate fossils for project sites containing units of high paleontologic sensitivity;

3. Information that the PRS or PRM has the authority to halt or redirect construction in the event of a discovery or unanticipated impact to a paleontological resource;

4. Instruction that employees are to halt or redirect work in the vicinity of a find and to contact their supervisor and the PRS or PRM;

5. An informational brochure that identifies reporting procedures in the event of a discovery;

6. A WEAP certification of completion form signed by each worker indicating that he/she has received the training (see attached form); and

7. A sticker that shall be placed on hard hats indicating that environmental training has been completed.

Verification: At least 30 days prior to ground disturbance, the project owner shall submit the proposed WEAP to the CPM for review and approval. The WEAP shall include the brochure with the set of reporting procedures for workers to follow.

At least 30 days prior to ground disturbance, the project owner shall submit the script and final video to the CPM for approval if the project owner is planning to use a video for interim training.

If the owner requests an alternate paleontological trainer, the resume and qualifications of the trainer shall be submitted to the CPM for review and approval prior to installation of an alternate trainer. Alternate trainers shall not conduct training prior to CPM authorization.

In the monthly compliance report (MCR), the project owner shall provide copies of the WEAP certification of completion forms with the names of those trained and the trainer or type of training (in-person or video) offered that month. The MCR shall also include a running total of all persons who have completed the training to date.

PAL-5 The project owner shall ensure that the PRS and PRM(s) monitor consistent with the PRMMP all construction-related grading, excavation, trenching, and augering in areas where potential fossil-bearing materials have been identified, both at the site and along any constructed linear facilities associated with the project. In the event that the PRS determines full-time monitoring is not necessary in locations that were identified as potentially fossil-bearing in the PRMMP, the project owner shall notify and seek the concurrence of the CPM.

The project owner shall ensure that the PRS and PRM(s) have the authority to halt or redirect construction if paleontological resources are encountered.

The project owner shall ensure that there is no interference with monitoring activities unless directed by the PRS. Monitoring activities shall be conducted as follows:

1. Any change of monitoring from the accepted schedule in the PRMMP shall be proposed in a letter or email from the PRS and the project owner to the CPM prior to the change in monitoring and will be included in the monthly compliance report. The letter or email shall include the justification for the change in monitoring and be submitted to the CPM for review and approval.

2. The project owner shall ensure that the PRM(s) keep a daily monitoring log of paleontological resource activities. The PRS may informally discuss paleontological resource monitoring and mitigation activities with the CPM at any time.

3. The project owner shall ensure that the PRS notifies the CPM within 24 hours of the occurrence of any incidents of non-compliance with any paleontological resources conditions of certification. The PRS shall recommend corrective action to resolve the issues or achieve compliance with the conditions of certification.

4. For any significant paleontological resources encountered, either the project owner or the PRS shall notify the CPM within 24 hours, or Monday morning in the case of a weekend event, where construction has been halted because of a paleontological find.

The project owner shall ensure that the PRS prepares a summary of monitoring and other paleontological activities placed in the monthly compliance reports. The summary will include the name(s) of PRS or PRM(s) active during the month, general descriptions of training and monitored construction activities, and general locations of excavations, grading, and other activities. A section of the report shall include the geologic units or subunits encountered, descriptions of samplings within each unit, and a list of identified fossils. A final section of the report will address any issues or concerns about the project relating to paleontologic monitoring, including any incidents of non-compliance or any changes to the monitoring plan that have been approved by the CPM. If no monitoring took place during the month, the report shall include an explanation in the summary as to why monitoring was not conducted.

Verification: The project owner shall ensure that the PRS submits the summary of monitoring and paleontological activities in the MCR. When feasible, the CPM shall be notified 10 days in advance of any proposed changes in monitoring different from the plan identified in the PRMMP. If there is any unforeseen change in monitoring, the notice shall be given as soon as possible prior to implementation of the change.

PAL-6 The project owner, through the designated PRS, shall ensure that all components of the PRMMP are adequately performed including collection of fossil materials, preparation of fossil materials for analysis, analysis of fossils, identification and inventory of fossils, the preparation of fossils for curation, and the delivery for curation of all significant paleontological resource materials encountered and collected during project construction.

Verification: The project owner shall maintain in his/her compliance file copies of signed contracts or agreements with the designated PRS and other qualified research specialists. The project owner shall maintain these files for a period of three years after project completion and approval of the CPM-approved paleontological resource report (see **PAL-7**). The project owner shall be responsible for paying any curation fees charged by the museum for fossils collected and curated as a result of paleontological mitigation. A copy of the letter of transmittal submitting the fossils to the curating institution shall be provided to the CPM.

PAL-7 The project owner shall ensure preparation of a Paleontological Resources Report (PRR) by the designated PRS. The PRR shall be prepared following completion of the ground-disturbing activities. The PRR shall include an analysis of the collected fossil materials and related information, and submit it to the CPM for review and approval.

The report shall include, but is not limited to, a description and inventory of recovered fossil materials; a map showing the location of paleontological resources encountered; determinations of sensitivity and significance; and a statement by the PRS that project impacts to paleontological resources have been mitigated below the level of significance.

Verification: Within 90 days after completion of ground-disturbing activities, including landscaping, the project owner shall submit the PRR under confidential cover to the CPM.

Certification of Completion
Worker Environmental Awareness Program
HIDDEN HILLS SOLAR ELECTRIC GENERATING SYSTEM
(11-AFC-02)

This is to certify these individuals have completed a mandatory California Energy Commission-approved Worker Environmental Awareness Program (WEAP). The WEAP includes pertinent information on cultural, paleontological, and biological resources for all personnel (that is, construction supervisors, crews, and plant operators) working on site or at related facilities. By signing below, the participant indicates that he/she understands and shall abide by the guidelines set forth in the program materials. Include this completed form in the Monthly Compliance Report.

No.	Employee Name	Title/Company	Signature
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Cultural Trainer: ______________ Signature: ___________________ Date: ___/___/____

PaleoTrainer: _______________ Signature: ___________________ Date: ___/___/____

Biological Trainer: ______________Signature:________________ Date: ___/___/__

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GEOLOGY and PALEONTOLOGY

List of Comment Letters

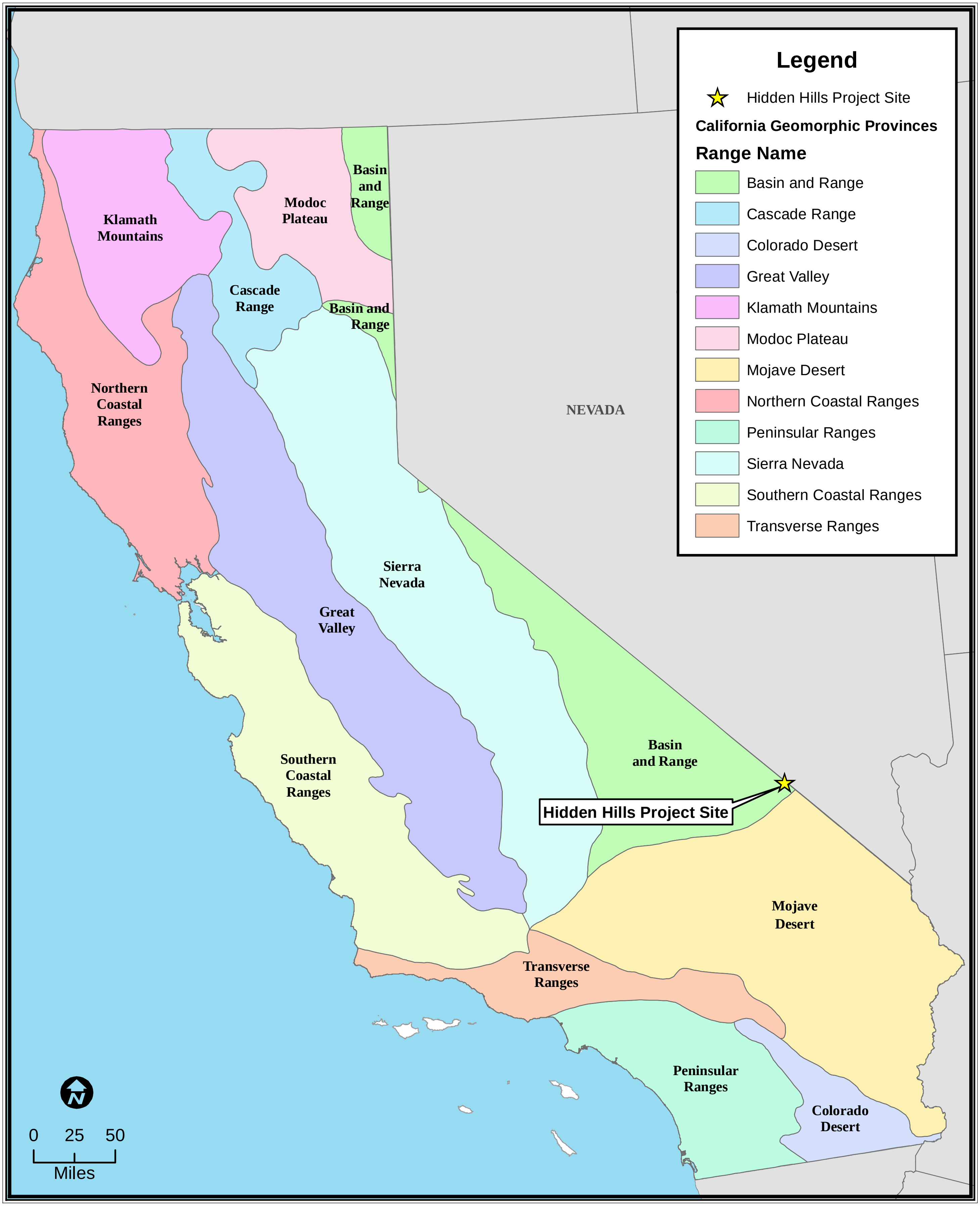
		Geo / Paleo Comments?
1	Inyo County	
2	Bureau of Land Management	
3	National Park Service	
4	The Nature Conservancy	
5	Amargosa Conservancy	
6	Basin & Range Watch	
7	Pahrump Paiute Tribe	
8	Richard Arnold, Pahrump Piahute Tribe	
9	Big Pine Tribe of Owens Valley	
10	Intervenor Cindy MacDonald	
11	Intervenor Center for Biological Diversity	
12	Intervenor, Old Spanish Trail Association	
13	Applicant, BrightSource Energy, Inc.	X

Comment #	DATE	COMMENT TOPIC	RESPONSE
13	**July 23, 2012**	**Applicant, BrightSource Energy**	
13.1	**p. 194**	Addition of BLM in LORS table	BLM reference incorporated into LORS table
13.2	**p. 194**	Italicize Latin epithets	Unnecessary and not incorporated
13.3	**p. 194**	Clarification of effects relatible to their significance.	Comments accepted and incorporated
13.4	**p. 194**	Change "or" to "and"	Comment not accepted. Would change meaning of sentence and be incorrect English.
13.5	**p. 195**	Emphasize significance to cumulative impacts	Comments accepted and incorporated
13.6	**p. 195**	Emphasize significance to impacts	Comments accepted and incorporated
13.7	**p. 195**	Different description of Antiquities Act	Comments accepted and incorporated

13.8	p. 195	Delete duplication of reference to NEPA	Comments accepted and incorporated
13.9	p. 195	Different description of Omnibus Public Land Management Act	Comments accepted and incorporated
13.10	p. 196	Different description of CEQA, Appendix G	Comments accepted and incorporated
13.11	p. 196	Requested addition of BLM reference to LORS table	Comments accepted and incorporated
13.12	p. 196	Requested revision to project description	Comments accepted and incorporated
13.13	p. 196	Requested rewording description of regional geology to replace "metamorphism" to "diagenisis"	Comment not accepted. The description of the occurance of metamorphic rocks is clearly described in the preceeding paragraph. Text is accurate as presented.
13.14	p. 196	Requested rewording description of regional geology to replace "metamorphosed rocks" to "crust"	Comment not accepted. The description of the occurance of metamorphic rocks is clearly described in the preceeding paragraph. Text is accurate as presented.
13.15	p. 196	Emphasized development of rainshadow caused desertification of "Great Basin"	Comments accepted and incorporated
13.16	p. 196	Requested removal of the word "abandoned" referring to nonfunctioning onsite groundwater wells	Replaced "abandoned" with the word "nonfunctioning"
13.17	p. 197	Applicant states case law notes that imapcts analysis under CEQA is limited to potential effects of the project on the environment and not effects or risks to the project or people from the environment and requests removal of bullet under Method and Threshold for Determining Sinificance that states such.	Comment not accepted. Case cited is not relevant to this section
13.18	p. 197	Requested inclusion of BLM 2008 in text reference	Comments accepted and incorporated
13.19	p. 197	rearrangement of words to emphasize significance of adverse impacts	Comments accepted and incorporated
13.20	p. 197	Requested inclusion of BLM 2008 in text reference	Comments accepted and incorporated
13.21	p. 197	Requested change from the word "reconnaissance"to "survey".	Even though the Applicant's documents used the word "reconnaissance" through out its documents, the requested revisons have been accepted and incorporated.

13.22	p. 197	Requested the removal of reference to "dry lake" as a deposit where fossils would typically be found.	Comment partially accepted. Numerous articles in literature refer to dry lakes as yielding significant geological resources. Maybe none more notable than Fossil Lake in Oregon. It is interesting to note that the recent mission to Mars was focused on an ancient lake bed to search for evidence of life. For clarification, the words dry lake deposits have been replaced with "subsurface lacustrine deposits"
13.23	p. 197	Requested change to require monitoring of excavations unless and until sediments with high paleontological sensitivity are identified in the project area.	Comment not accepted. The absence of evidence is not evidence of absence. Monitoring must occur until and unless the Paleontological Resources Specialist (PRS) recommends to the CPM that monitoring is not necessary and that the CPM agrees with the PRS recommendation.
13.24	p. 198	Requested clarification that eathwork would be halted specifically in the immediate area of a paleontological find.	Comments accepted and incorporated
13.25	p. 198	Requests revision to allow PRS to determine changes in monitoring protocol without CEC approval of that change.	Comment not accepted. The CPM can authorize changes in monitoring protocol based on the PRS recommendation. The PRS does not have independent unilateral authority to make changes in CEC approved monitoring protocol.
13.26	p. 198	Requests specification that impacts would be mitigated to insignificant levels.	Comments accepted and incorporated
13.27	p. 198	Requests rewording cumulative impacts section by minimizing the potential of encountering paleontological resources during construction. Also requests adding clarification that adherence to Conditions of Certification would mitigate any potential cumulative impacts to insignificant levels.	Comment partially accepted. The absence of evidence is not evidence of absence. The discussion of the difference in geology between the site and Stump Springs is superfluous and is not accepted. In the comments, the applicant did state that paleontologically sensitive sediments have been found along limited sections of the project's linears. That statement has been accepted and incorporatated into the document. The inclusion of the phrase adherence to Conditions of Certification would mitigate any potential cumulative impacts to insignificant levels is accepted and incorporated.

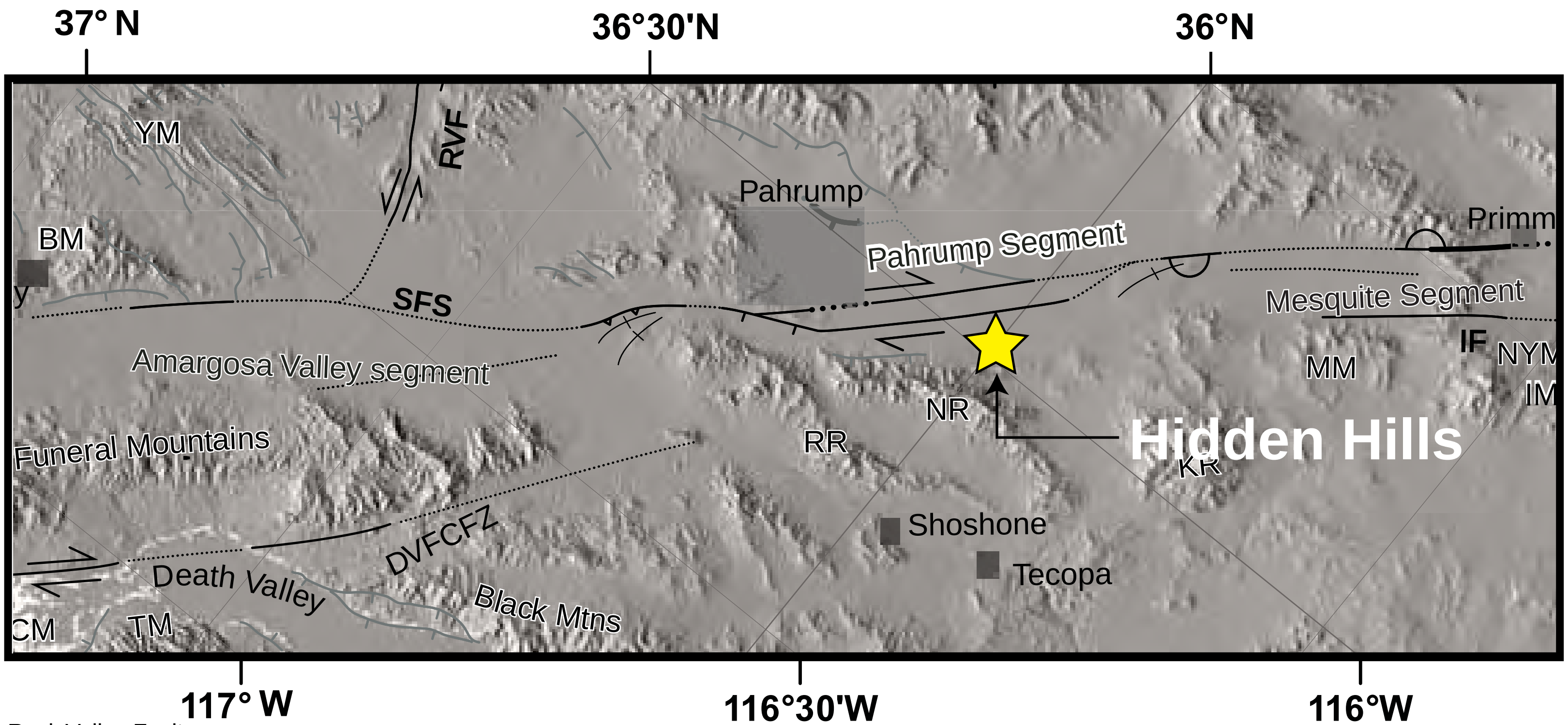
GEOLOGICAL RESOURCES - FIGURE 3
Hidden Hills Solar Electric Generating System (HHSEGS) - Geomorphic Provinces



CALIFORNIA ENERGY COMMISSION - SITING, TRANSMISSION AND ENVIRONMENTAL PROTECTION DIVISION
SOURCE: California Department of Conservation, California Geological Survey, 2002.

GEOLOGICAL RESOURCES - FIGURE 1

Hidden Hills Solar Electric Generating System (HHSEGS) - Fault Map



RVF - Rock Valley Fault
DVFCFRZ - Death Velley Furnace Creek fault zone
SFS - Stateline fault system
YM - Yucca Mountain
BM - Bare Mountain
CM - Cottonwood Mountain
TM - Tucki Mountain
RR - Resting Spring Range
NR - Nopah Range
MM - Mesquite Mountain
IM - Ivanpah Mountain
NYM - New York Mountains

N

Inferred fault location

Mapped fault location with arrows showing relative direction of fault movement

Fold

Thrust fault—Sawteeth on upper plate

Location of offset geologic unit

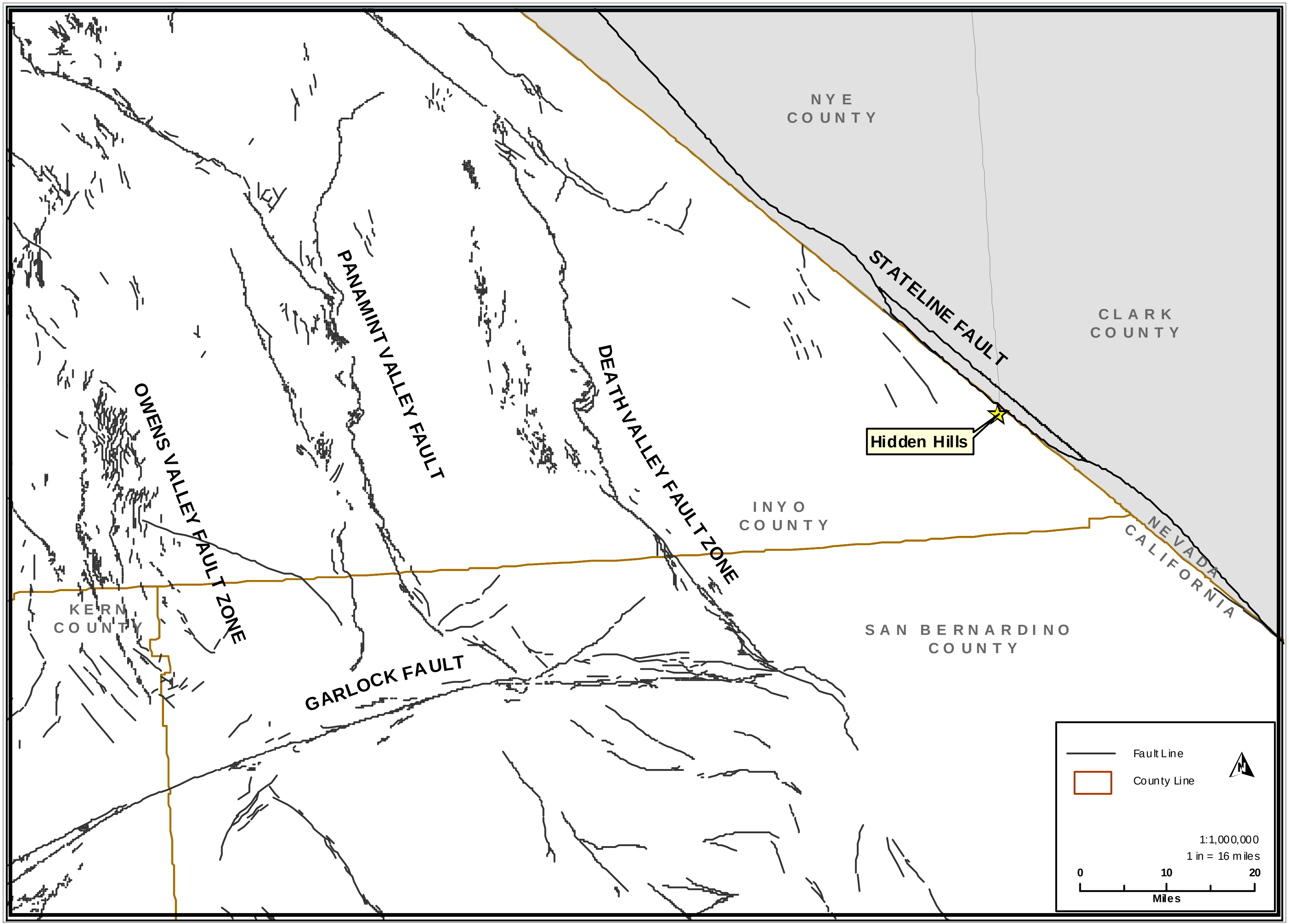
Scale
1” = 13.636 Miles

CALIFORNIA ENERGY COMMISSION - SITING, TRANSMISSION AND ENVIRONMENTAL PROTECTION DIVISION

SOURCE: Ground Water Atlas of the US_HA 730-B_Figure 36_ Pahrump Valley geology_http://pubs.usgs.gov/ha/ha730/ch_b/basin_range4.html
Geological Society of America Bulletin, Nov/Dec 2007

GEOLOGICAL RESOURCES - FIGURE 2

Hidden Hills Solar Electric Generating System (HHSEGS) Regional - Fault Map



CALIFORNIA ENERGY COMMISSION, SITING, TRANSMISSION AND ENVIRONMENTAL PROTECTION DIVISION

SOURCE: Dept of Conservation - California Geological Survey - 2010 Fault Activity Map of California

Geological Society of America Bulletin, Nov/Dec 2007

GEOLOGICAL RESOURCES - FIGURE 4

Hidden Hills Solar Electric Generating System (HHSEGS) - General Geologic Map

EXPLANATION

Basin-fill deposits

- Quaternary playa deposits
- Quaternary and Tertiary unconsolidated coarse-grained deposits
- Quaternary and Tertiary lacustrine and associated fine-grained deposits

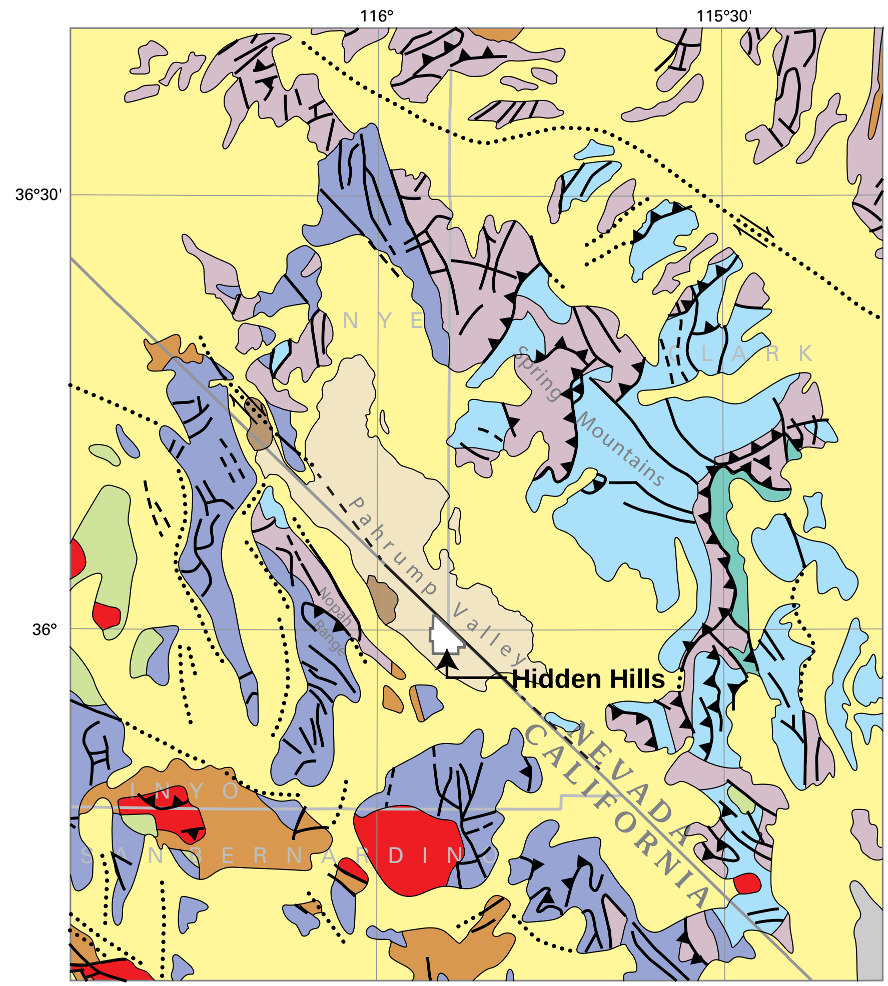
Consolidated Rocks

- Tertiary consolidated deposits
- Tertiary to Triassic marine and continental rocks
- Triassic to Mississippian carbonate rocks
- Devonian to Cambrian carbonate and clastic rocks
- Cambrian and Precambrian clastic rocks
- Quaternary and Tertiary volcanic rocks
- Miocene to Triassic intrusive rocks
- Precambrian basement rocks

Fault—Dashed where approximately located. Dotted where concealed Arrows show relative movement

Thrust fault—Sawteeth on upper plate

Inferred fault location



Base modified from U.S. Bureau of the Census TIGER/Line files, 1:100,000, 1990

Modified from Plume and Carlton, 1988 and Harrill, 1986

SCALE 1:1,000,000

N

0 5 10 15 MILES

0 5 10 15 KILOMETERS

Plume, R.W., and Carlton, S.M., 1988, Hydrogeology of the Great Basin region of Nevada, Utah, and adjacent States: U.S. Geological Survey Hydrologic Investigations Atlas HA–694–A.

Harrill, J.R., 1986, Ground-water storage depletion in Pahrump Valley, Nevada–California, 1962–75: U.S. Geological Survey Water-Supply Paper 2279, 53 p.

SOURCE: Ground Water Atlas of the US_HA 730-B_Figure 36_ Pahrump Valley geology_http://pubs.usgs.gov/ha/ha730/ch_b/basin_range4.html